Fisheries and Oceans Canada | Pêches et Océans Canada
Science | Sciences
Pacific Region
Canadian Science Advisory Secretariat
Science Advisory Report 2012/037

2011 MARINE SURVIVAL FORECAST OF SOUTHERN BRITISH COLUMBIA COHO

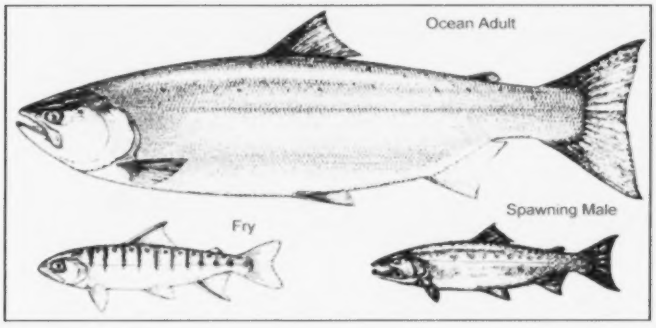

Figure 1: Coho salmon at three life stages: freshwater rearing fry; ocean rearing adult; and returning male. This image has been used on previous coho Stock Status reports, origin unknown.

Figure 2: The Province of British Columbia, showing the major rivers in the South Coast, Lower Fraser and Interior BC areas.

Context

Forecasts for Southern British Columbia coho salmon stocks form part of the annual and are essential for planning fisheries pre-season, and for bounding expectations of run size in-season. Southern BC coho forecasts consist of pre-season estimates of marine survival for coho stocks originating from South-west Vancouver Island, Georgia Basin – East, Georgia Basin – West, and the Lower Fraser. For the Interior Fraser River Management Unit, total post-season abundance is forecasted. For the Johnstone Strait/Mainland Inlets Management Unit, total post-season abundance for a selected group of creeks is forecasted.

This report presents a forecast for southern BC coho returning in 2011, for the most part, based on the methodology reviewed and approved in last comprehensive assessment of southern BC coho salmon which was reviewed through the Canadian Science Advisory Secretariat in 2004. Detailed descriptions of the data sources, their assumptions and uncertainties, and the models can be found in (Simpson et al. (2004). Since 2005 the forecast report has been published in most years as a Science Advisory Report.

This Science Advisory Report has resulted from a Fisheries and Oceans Canada, Canadian Science Advisory Secretariat Regional Advisory Process. Additional publications resulting from this process will be posted as they become available on the DFO Science Advisory Schedule at http://www.dfo-mpo.gc.ca/csas-sccs/index-eng.htm.

Canada

SUMMARY

- The southern BC coho assessment provides estimates of marine survival in 2010 and forecasts for 2011 for coho salmon stocks originating from South-west Vancouver Island, Georgia Basin – East, Georgia Basin – West, and the Lower Fraser. For the Interior Fraser River Management Units, total 2010 spawning escapement and 2011 pre-season abundance is provided. For the Johnstone Strait/Mainland Inlets Management Unit the summed 2010 spawning escapement from selected rivers and 2011 pre-season abundance is provided.
- Coho marine survival and abundance continues to remain low (less than 3%) for most southern BC coho stocks compared to the early 1970's (15-20%). Of particular note, the 2011 Interior Fraser River Interior and Thompson Aggregates are forecasted to decline in abundance in 2011.
- In light of the abundance trend, coupled with the continuing low marine survival rates of southern BC coho stocks, the forecast of marine survival and abundance should be characterized as extremely low, with except possibly for the west coast of Vancouver Island.
- The 2010 marine survival for West Coast indicator stocks, Robertson Creek (enhanced) and Carnation Creek (wild) were assessed at 3.3% and 1.0%, respectively. The 2011 marine survivals, based on favourable survival conditions and using newer, but not reviewed growth model, is forecast to increase over the observed values from the previous year.
- The last full assessment of southern BC coho was reviewed and endorsed through CSAS in 2004, with subsequent assessments presented in the form of a Science Advisory Report using the approved methodology. A full review of the assessment (forecast) methodology is recommended for future assessments to account for the addition/loss of indicator streams, change in enumeration methodology and model development that has occurred since 2004.
- Monitoring programs for coded-wire tagged, adipose fin clipped coho must be maintained or strengthened to continue to monitor southern B.C. coho populations.

INTRODUCTION

During the 1990s DFO Fisheries Management and Stock Assessment divisions observed an unprecedented decrease in the marine survival of southern British Columbia coho populations. Hatchery indicator stocks decreased from a mean survival of 6.6% (Brood Year (BY) 1983-1992) to 2.5% (BY 1993-2001) and wild indicator stocks from 10.2% to 4.4% during the same time period. In response, all directed coho fisheries were curtailed to protect weaker stocks such as Thompson River and Strait of Georgia coho. This management action resulted in a decrease of the total exploitation rate (all sectors) from a mean of 67% (BY 1983-1994) down to 17% (adipose fin clip (AFC) coho, BY 1995-2001) and 4% (non-AFC coho).

These measures allowed more coho salmon to return to natal creeks. Bradford et al. (2000) found that a minimum rate of 3% marine survival is required for a wild, coastal population to sustain itself. Hatchery indicators can withstand lower levels of marine survival because of the higher egg to fry survival rates of these stocks.

The scope for this forecast is southern British Columbia , which comprises seven Management Units (MU):

Johnstone Strait/Mainland Inlets (JST): Johnstone Str., Queen Charlotte Str., and adjacent inlets (Areas 11, 12 and the northern portion of Area 13). The indicator data consists of the return (catch plus escapement) of a group of monitored streams.

Northwest Vancouver Island (NWVI): Estevan Pt. to Cape Scott (Areas 25-27). There are no indicators in this MU.

Southwest Vancouver Island (SWVI): Victoria to Estevan Pt. (part of Area 19 (sub-areas 1 to 4) and Areas 20-24). There is one wild indicator (Carnation Creek) and one hatchery indicator (Robertson Hatchery).

Georgia Basin – East (GBE): east side of the Str. of Georgia excluding the Fraser R. system (Areas 15, 16, 28 and the coastal foreshore streams in Area 29). Myrtle Creek, a wild indicator has been operating since 2000 and will be used for the 2010 Forecast. Currently there is no hatchery indicator available however Lang Creek Hatchery has started releasing coded-wire tagged coho smolts in 2009 and will be available after several years of returns.

Georgia Basin – West (GBW): west side of the Str. of Georgia (Areas 13 (southern portion), 14, 17, 18 and the Str. of Georgia portion of Area 19 (sub-areas 5 to 12)). There is one wild indicator (Black Creek) and three hatchery indicators (Quinsam, Big Qualicum and Goldstream Hatcheries).

Lower Fraser (LowFr): Lower Fraser R. system as far upstream as Hell's Gate (Area 29). There is one hatchery indicator (Inch Hatchery) and one wild indicator (Salmon River), which discontinued operations after spring 2005 and restarted in fall 2006. Operations were discontinued again in 2009.

Interior Fraser (IntFr): upstream from Hell's Gate, including the Thompson R. system (Area 29). The indicator data used for this MU is the estimated total escapement into the MU, including North Thompson, South Thompson, Lower Thompson and non-Thompson Fraser coho.

ASSESSMENT

The assessment method used to produce the 2011 forecast was developed and approved though a Canadian Science Advisory Secretariat (CSAS) Regional Advisory Process in 2004. reviewed and approved though 2004. Detailed descriptions of the data sources, their assumptions and uncertainties, and the models can be found in (Simpson et al., 2004). The following provides a brief overview.

Coho populations are managed by using a representative stock as an indicator for a larger management unit. The approach is to use a stock in which the number of smolts leaving freshwater for the marine areas, and the adults returning back to spawn can be estimated with a high degree of precision. This method takes advantage of the coded-wire tagging program which has programs in place to recovery tagged coho and chinook from commercial, sport, and First Nations sectors and allows the inclusion of escapement tag recovery.

For the hatchery indicators, a cohort of smolts is coded-wire tagged, adipose fin clipped and released. This group of tagged coho is followed through the fisheries (where possible) and is enumerated when they return to their natal creeks. Freshwater fisheries are monitored and included as escapement and marine survival is calculated for the entire management unit.

For the wild indicators, the smolts are coded-wire tagged only. The escapement is monitored at enumeration weirs and the coho are tested with a CWT Wand Detector to establish the presence or absence of a coded-wire tag.

The marine exploitation is estimated by comparing the 2010 fishing effort with a base period (1987-1997) when coho by-catch was monitored in non-target fisheries.

To develop the forecast, coded-wire tagged / adipose fin clipped (CWT/AFC) coho are collected to estimate freshwater fishing mortality and escapement from the previous forecast year for indicator stocks. Exceptions to this approach are the Interior Fraser River (Thompson) and selected Area 12/13 coho populations where escapement is forecasted, and the Goldstream Hatchery indicator where exploitation information must be based on tag recoveries, as there are no coded-wire tag catch data from this stock available for the baseline period. These data are then applied to the each of several potential forecast models (see model descriptions below) and the predictive power of each model is assessed. The forecast resulting from the model that best fits the past data is then selected to use for the next forecast year.

Environmental parameters used in the assessment model include salinities from February and March of the current year from Chrome and Sisters Islets to forecast an index of distribution.

Forecast models

Time Series Models

- *'Like last year' (LLY):* the forecasted survival or abundance will remain the same as that observed in the previous year;
- *Three year average (3YRA)*: the forecasted survival or abundance will equal the mean of the previous three years of observed values;
- *One year trend (RAT1):* the change in survival or abundance from last years observed to this years forecast will equal the previous change (from that observed two years ago to that observed last year); and,
- *Average three year trend (RAT3*): the change in survival or abundance from last years observed value to this years forecast will equal the mean of the previous three changes.

Biological Models

- *Sibling Model:* This forecasts the adult return to an indicator using a regression that relates past adult returns to the escapement of jacks one year prior. Forecast returns to hatcheries are converted to forecasts of survival by dividing returns by the smolt releases.
- *Euphausiid Model:* This model forecasts the return to Carnation Creek using a regression that relates past adult returns to the abundance of a euphausiid species in Barkley Sound one year prior. This species is an important prey for coho in Barkley Sound.
- *CPUE Model:* This is a forecast of the total return of CWT/AFC coho for the three hatchery indicators in the Georgia Basin: Quinsam, Big Qualicum and Inch. A research vessel is used to sample juvenile coho in July of their first year in the Strait of Georgia. The catch of AFC coho is related in a regression to the CWT/AFC return to these hatcheries the following year. The catches are from a standard trawl survey conducted annually. The return forecast is then divided by the total CWT/AFC release from the hatcheries to provide a marine survival forecast. There are other sources of AFC coho that can be found in the

Strait including Puget Sound however the releases from the hatcheries are used as an index of the AFC coho population in the Strait of Georgia.

- *Stock-Recruit Model:* The time series of standardized escapements and returns to Area 12 and Area 13 streams were used as inputs to Ricker stock-recruitment analyses, which were then used to forecast recruitment and returns using observed spawner indices in the brood year.
- *Growth Model:* This model was recently proposed by Dr. Marc Trudel (Pacific Biological Station, Nanaimo, BC). (Trudel et al., 2008). It is based on the hypothesis that larger and faster growing fish have higher marine survival either because they are more successful at escaping predators or accumulate enough energy to survive winter starvation (Beamish and Mahnken, 2001). Growth is estimated for juvenile coho salmon caught in a trawl survey off the west coast of Vancouver Island during fall (October-November) as the difference between size at capture and size at ocean entry divided by the time spent at sea (Trudel et al., 2007).
- *Distribution Forecast:* Young coho originating in the Georgia Basin are thought to rear in the Strait of Georgia until the fall, when they primarily migrate to the west coast of Vancouver Island. A varying proportion return to the Strait soon after, in late winter, and are available to 'inside' fisheries in their last year at sea. This proportion has been related to salinity in the strait in this late winter period: low salinities are associated with few coho returning early. The salinity model predicts the proportion of catch taken in the Strait of Georgia , if pre-1997 fishing regimes were in place and this proportion, P_{inside}, is now used as an index of inside distribution. P_{inside} should not be interpreted as the proportion that is occupying the strait in their last year.

Changes to Assessment Methods

Since the last comprehensive assessment of southern BC coho salmon in 2004 (Simpson et al., 2004), there have been several modifications, additions and deletions to the indicators, data sources, and one new model has been added. These changes are noted below.

Indicators

There have been three new indicators added since 2004 and two indicators that are no longer used, as follows:

- Goldstream is a hatchery based indicator in the Georgia Basin West Management Unit, located in Saanich Inlet near Victoria. Coho production started with broodyear 1978 and coded-wire tagging was initiated with broodyear 1991.
- Myrtle Creek is a wild indicator that was established in 2000 with the first coded-wire tagged coho released in 2001. This is a relatively small population located in the Georgia Basin East Management Unit, near Powell River. It was included in the annual coho forecast in the 2010 forecast report. Like Goldstream, there is no exploitation rate baseline data, however, the modeled Black Creek ER is assumed to be similar, so it is used for Myrtle Creek.
- The upper Fraser Aggregate, which includes the Thompson River Aggregate, has been added to the Upper Fraser Management Unit. The dataset for this indicator has been maintained.

- The Chilliwack Hatchery indicator is no longer included after ceasing the application of coded-wire tags to coho releases after the 2002 brood year. This hatchery is located in the Lower Fraser management unit, near Chilliwack.
- The Salmon River wild indicator is no longer included after it ceased operations after the Spring 2005 season. This project was re-started in the fall of 2006, but shut down again after Spring 2009. This indicator is located in the Lower Fraser Management Unit, near Langley.

Sources of data

There were two changes to data sources.

The first data source change was the estimate of the escapement of Robertson Creek Hatchery adipose fin clipped coho. The original estimates were generated by enumerating the returning coho into the hatchery channels and sub-sampling this population for frequency of adipose clipped coho and presence of coded-wire tags. An unknown proportion of the escapement does not return to the hatchery, but remained in the Stamp River. There were also periods when the hatchery channels were shut off to incoming salmon, due to overwhelming numbers already at the hatchery. Both situations resulted in a low bias of the estimate of returning coho.

In 1999, an enumeration system was installed at the Stamp Falls fishway that used video recordings of the migrating coho to estimate the number of escapement and the adipose fin status. This data set was considered by DFO Stock Assessment staff to be more accurate than the estimates generated by the Robertson Hatchery and is included in the forecast, along with the forecast using the previously approved data.

A second data source change was switching to the use of coded-wire tagged information for the SW Vancouver Island wild indicator, Carnation Creek. Previously, the number of adults returning was forecast. The first smolts tagged were the 1999 brood year.

The forecast model for Carnation Creek is based on the correlation of the abundance of euphausiid (*Thysanoessa spinifera)* with different metrics of Carnation Creek coho production. Initially, returns per smolt was used as the correlate, however, subsequent results of coded-wire tagging showed that some of the the adult return did not come from the group of smolts, suggesting it is not a good measure of marine survival (Simpson et al., 2004). Subsequently the absolute return of adults was used as a correlate until an adequate time series of coded-wire tagged based marine survivals could be used.

Both Robertson Hatchery and Carnation Creek are located in the Southwest Vancouver Island Management Unit, in Barclay Sound and are used to represent the Northwest Vancouver Island Management Unit as well.

Forecast Models

A new coho marine survival forecast model has been developed but not fully reviewed as a method of forecasting Coho Samon (Trudel et al., 2007, Trudel et al., 2008). This model is based on a correlation between marine growth during the first marine summer and observed marine survivals from Carnation Creek and Robertson Creek Hatchery. For the Stamp Falls and Carnation Creek forecasts, the Marine Growth model forecast result is also presented.

Distribution and Timing Model

The Distribution Model is used to describe the timing of coho returning back to the Strait of Georgia. A correlation between the proportion of hatchery indicator stocks that are taken in fisheries wholly within the Strait of Georgia ("P_{inside}"), and the salinity measured at two

lighthouse stations in the Strait of Georgia is used to forecast this metric. This correlation is based on a time period when coho fisheries were much less restricted than they are now. This statistic predicts the proportion of coho that would be caught in the Strait of Georgia, given similar fishing effort however since 1997 the coho fishery has been highly restricted.

Sources of Uncertainty

Commercial by-catch of coho

There are no direct Canadian coho fisheries so any exploitation is the result of bycatch of coho in other fisheries. The coho caught in these fisheries are not monitored for adipose clips. The exploitation rates are estimated by using the by-catch of Indicator origin coho in non-targeted commercial fisheries from a base period of return years 1987 – 1997, and comparing the effort from this base period to the effort in 2010.

Sport catch

CWT-based estimates of sport fishing mortality have become less certain due to decreased participation by sport fishers in submitting adipose clipped head samples. An additional source of uncertainty is the unknown number of mortalities from the increased number of released catch in a mark-selective fishery. Prior work has shown that 10% of the released coho do not survive however in recent years the pinniped population has learned to follow recreational vessels and prey upon released coho so a 10% release mortality should be considered as a minimum rate.

Freshwater creel surveys were limited to Quinsam River, Nicomen Slough (Inch Creek Hatchery) and the Fraser River. Other freshwater fisheries were not monitored.

Predictive power of the time series models

The time series models used in this forecast assume that the observations from the past will continue into the future. The models have no predictive capability for changes to that trend.

Spawning Escapement and Abundance Estimates (Interior Fraser)

Annually spawning escapements for Interior Fraser River (Thompson) system are calculated summing individual escapement estimates for approximately 100 streams. The precision of the spawning estimate varies considerably between those intensively sampled (in the spawning surveys range considerably through the summation of extensive (low/unknown precision) and intensive (known precision) enumeration methods on approximately 100 streams within the interior watershed. Surveys are designed to reduce the amount of variability in the escapement estimates within and between systems, but the total precision of the aggregate estimate for Interior Fraser Coho is unknown.

Stock trends

Since the early 1970's, marine survival of coho salmon has decreased from a range of 10% - 20% down to less than 2%. The majority of the observed marine survival estimates for the 2010 return continued to be at the bottom of this range. The notable exception was 2009 when the returns of coho in all areas were above the recent low values. Coho marine survival continues to remain low (less than 3%) for most southern B.C. coho stocks compared to the early 1970's (15-20%).

Table 1. Forecasted 2010 and observed 2009 and 2010 coho marine survival rate (smolt to adult) or abundance (adult returns) by system, with 50% confidence intervals for forecasted 2010 values, and distribution index . The Model column indicates which of the potential forecast models was used based on best fit analysis. The Salinity model is used to forecast the distribution index of when coho return to the Strait of Georgia.

	2009	2010			2010	Change	Change
	Observed	Forecast	50% CI	Model	Observed	from forecast	from 2009
Johnstone Strait/Mainland Inlets							
Area 12	1,904	1,193	790 - 1904	3YRA	1,427	20%	-25%
Area 13	581	374	247 - 567	3YRA	294	-21%	-49%
Georgia Basin - West							
Big Qualicum Hatchery	0.004	0.004	0.002 - 0.006	LLY	0.005	39%	39%
Quinsam Hatchery	0.013	0.008	0.006 - 0.012	3YRA	0.008	0%	-40%
Goldstream Hatchery	0.010	0.005	0.002 - 0.015	3YRA	0.007	22%	-32%
Black Creek (wild)	0.0280	0.017	0.011 - 0.025	3YRA	0.016	-4%	-41%
Georgia Basin - East							
Myrtle Creek (wild)	0.038	0.048	0.010 - 0.203	RAT3	0.016	-67%	-58%
Lower Fraser							
Inch Hatchery	0.018	0.018	0.011 - 0.031	LLY	0.025	35%	35%
Str. Of Geo. Hatcheries	0.012	0.010	0.007 - 0.013	CPUE	0.013	27%	7%
Interior Fraser							
Interior Fraser watershed	24,443				41,470		70%
Thompson River aggregate	19,310	24,442	15,235 - 39,215	3YRA	34,771	42%	80%
South-west Vancouver Island							
Robertson (Stamp Falls) Hatchery	0.146	0.009	0.005 - 0.018	Sibling	0.033	267%	-77%
Carnation Creek (wild)	0.071	0.100	0.088 - 0.110	Euphausiid	0.010	-90%	-86%
Distribution Index (P_{inside})		0.264	0.0193 - 0.0350	Salinity			
Marine Growth model							
Robertson (Stamp Falls) Hatchery	0.146	0.049	0.040 - 0.060	Growth	0.033	-33%	-77%
Carnation Creek (wild)	0.071	0.015	0.010 - 0.020	Growth	0.010	-37%	-87%

Johnstone Strait/Mainland Inlets

The 2010 observed return in Area 12 was similar to the 2007 brood return and approximately 25% less than what was estimated for the previous year's return (2009). The Area 13 return demonstrated a 40% decline in abundance relative to the brood year (2007) and 50% lower than the previous year's return (2009). For the indicator system at Keogh River, smolt production in 2009 was well above average (78,000 fish) . Based on the observed 2010 returns at those and other systems in the area, marine survival has declined relative to the 2009 return.

North-west and South-west Vancouver Island

The 2010 coho marine survival of the wild stock (Carnation Creek) returned to the relatively low level from the exceptional 2009 observed marine survival. The 2010 Carnation Creek coho marine survival was 86% below the 2009 observed survival of 7.1%. The 2010 coho marine

survival of the hatchery stock (Robertson Creek) was 77% below the 2009 observed marine survival.

Georgia Basin West and Georgia Basin East

2010 coho marine survivals for the hatchery stocks (Big Qualicum, Quinsam and Goldstream) ranged between 0.5% and 0.7% (Table 1). Generally, these stocks are continuing to slowly increase from the low rate in the mid-2000 period. (Figure 4).

Marine survival of coho for the wild indicator stocks, Black Creek and Myrtle was 1.7% and 1.6% respectively; both well below 2009 observed marine survivals of 2.8% and 3.8%, respectively.

For the indicator system Black Creek, smolt production in 2009 was slightly above average (68,000 fish). Based on the observed 2010 returns, at those and other systems in the area, marine survival in 2010 declined relative to the 2009 return.

Lower Fraser

The 2010 marine survival of 0.025 for Inch Creek hatchery coho was above the 2009 marine survival of 1.8%.

Interior Fraser (Thompson)

The total abundance of coho salmon originating from the Interior Fraser River watershed, upstream of Hell's Gate and including the Thompson River watershed in 2010 was approximately 41,470 fish. The total abundance of coho salmon originating from the Thompson River portion of the watershed was 34,771 fish. The abundance of coho from the Interior Fraser in 2010 was higher than the abundance observed in 2009 (24,318 fish), but approximately 65% of the brood year abundance of 65,652 fish.

Exploitation rates (ER's) on Interior Fraser River coho from Canadian fisheries were derived from the post-season estimates generated from the CDFO coho fisheries effort model and the post-season Fraser River fisheries ER rate calculation model. For the forecasting exercise, U.S. impacts were modeled from the maximum allowed under the Pacific Salmon Treaty's abundance based management regime for Management Units in 'low' status (10%). The estimated exploitation rate for IFR coho in 2010 was approximately 13%. Total Canadian exploitation was estimated to be 3.08%.

Interior Fraser River are still experiencing low marine survival rates (<2% for hatchery stocks), however, coho returns in 2010 represented a reversal in the recent three year trend of increasing abundances where returns met or exceeded those observed in their corresponding brood year. The brood year abundance for the 2010 return was 65,652 fish (Figure 5).

2011 Forecasts

Table 2. Observed 2009 and 2010 coho marine survival rate (smolt to adult) or abundance (adults returns) by system, 2011 forecasts with 50% confidence intervals, and distributional index. The Model column indicates which of the potential forecast models was used based on best fit analysis. The salinity model is used to forecast the distribution index of when coho return to the Strait of Georgia.

	2009	2010	2011			Change (2011 forecast minus
	Observed	Observed	Forecast	50% CI	Model	2010 observed)
Johnstone Strait/Mainland Inlets						
Area 12	1,904	1,427	1,283	853 - 1932	3YRA	-10%
Area 13	581	294	327	217 - 494	3YRA	11%
Georgia Basin - West						
Big Qualicum Hatchery	0.004	0.005	0.005	0.003 - 0.009	LLY	0%
Quinsam Hatchery	0.013	0.008	0.009	0.006 - 0.013	3YRA	13%
Goldstream Hatchery	0.010	0.007	0.007	0.002 - 0.019	3YRA	6%
Black Creek (wild)	0.0280	0.016	0.014	0.010 - 0.021	3YRA	28%
Georgia Basin - East						
Myrtle Creek (wild)	0.038	0.016	0.021	0.008 - 0.054	3YRA	32%
Lower Fraser						
Inch Hatchery	0.018	0.025	0.025	0.015 - 0.042	LLY	0%
Str. Of Geo. Hatcheries	0.012	0.013	0.014	0.011 - 0.017	CPUE	9%
Interior Fraser						
Interior Fraser watershed	24,443	41,470	26,369	16,671 - 41,709	3YRA	-36%
Thompson River aggregate	19,310	34,771	21,706	13,594 - 34,657	3YRA	-38%
South-west Vancouver Island						
Robertson (Stamp Falls) Hatchery	0.146	0.033	0.085	0.069 - 0.104	Growth	158%
Carnation Creek (wild)	0.071	0.010	0.038	0.027 - 0.052	Growth	300%
Distribution Index (P_{inside})			0.282	0.207 - 0.371	Salinity	

Johnstone Strait/Mainland Inlets

The Area 12 and 13 2011 forecasts are approximately similar to the brood returns (parental brood year is 2008). The Area 12 and 13 forecasts are respectively 10% lower and 11% higher than the 2010 observed indices. Coho abundance in this region remains low and can be characterized as 'below average' for both Area 12 and 13 stocks. See Simpson et al., 2004 for description of characterizations. Smolt production in 2010 was well below average (28,000 fish vs. 63,000 fish) for Black Creek and slightly above average for Keogh River (61,000 fish vs. 58,000 fish) Table 2). Recent returns do not have the high levels of exploitation as in the past. These forecasts are highly uncertain.

North-west and South-west Vancouver Island

The new forecasting model, the marine growth model (Trudel et al., 2008) was compared to the existing suite of forecasting models using similar time periods and has shown a lower Mean Absolute Deviation (MAD) and Root Mean Square Error (RMSE), indicating a better forecasting performance that the models used. The 2010 observed marine survival was 33% (Robertson) and 37% (Carnation) lower than the forecast from this model and was at or outside the 50%

confidence limits (The observed Carnation marine survival was actually on the lower 50% bound).

The marine growth model is the preferred choice for the marine survival forecast. Comparisons of Mean Annual Deviation (MAD) and Root Mean Square Error (RMSE) for similar years show that this model has superior predictive power. The forecast marine survival for Robertson Creek Hatchery stock is 8.5%, while Carnation Creek (wild stock) is expected to be 3.5%. These marine survival forecasts are considerably higher than observed in 2010, but not as high as the observed marine survivals in 2009.

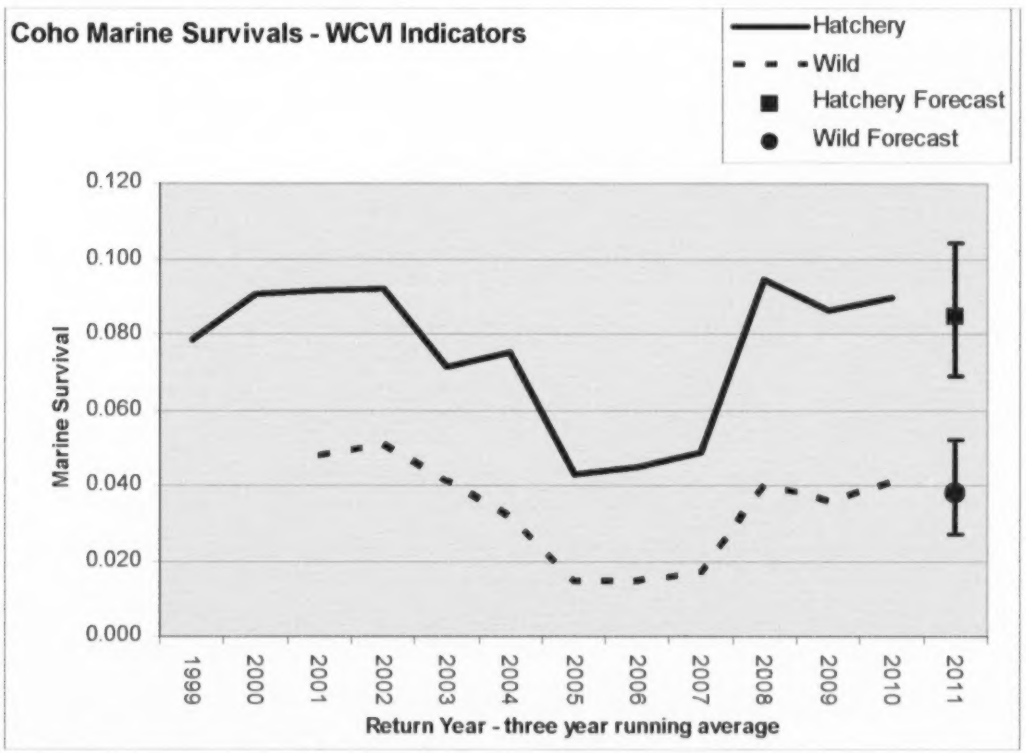

Figure 3. Coho marine survivals for South West Vancouver Island indicators.

Figure 3 shows the marine survival for wild (Carnation Creek) and hatchery (Robertson Hatchery) indicators, and the 2011 marine survival forecast including 50% confidence intervals. The data has been smoothed by plotting a running three year average. Both time series are based on a coded-wire tagged cohort. The Robertson Hatchery data series is based on the coded-wire tagged escapement estimates at Stamp Falls, not the return to the hatchery. The 2011 forecast data point is based on the Marine Growth model.

Georgia Basin West

The marine survival forecast for the wild indicator, Myrtle Creek, is 2.1%, an predicted increase of 32% over the observed 2010 marine survival of 1.6%, using the 3YRA time series model.

Georgia Basin East

The marine survival forecast for hatchery stocks, using the LLY and 3YRA models, is similar to levels observed in the previous years and is continuing to be extremely low at between 0.5%

and 0.9%. The wild indicator at Black Creek is forecast to decrease to 1.4% using the 3YRA model (Table 2)

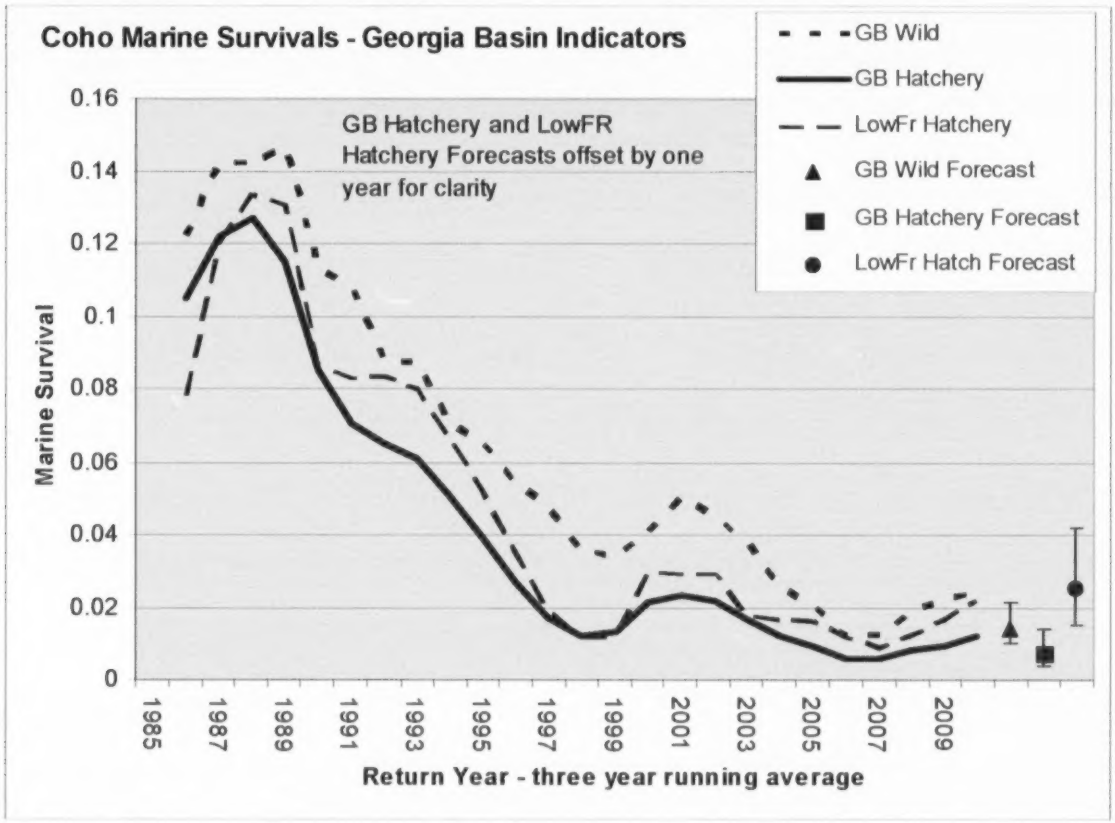

Figure 4. Coho marine survivals for Georgia Basin indicators (GBE, GBW and LowFr).

Figure 4 shows the marine survival for wild (Black Creek, Salmon River and Myrtle Creek) and hatchery (Quinsam, Big Qualicum, Inch, Chilliwack and Goldstream Hatcheries) indicators, the Lower Fraser Hatchery indicator (Inch Hatchery), and the 2011 marine survival forecast including 50% confidence intervals. The data has been smoothed by plotting a running three year average of the annual means.

Lower Fraser

The preferred forecast model used for 2011 is the LLY model for the hatchery indicator. The forecast is for 2.5% marine survival (Table 2).

Interior Fraser

The forecast for the Interior Fraser Watershed is based on the three-year geometric mean of wild escapements observed in the Interior Fraser Watershed. The forecast escapement for 2011 is 26,369 spawners. This value is still below the lower threshold escapement suggested in the IFR Coho Recovery Strategy, a level required to ensure that genetic integrity and demographic concerns are maintained in the entire Management Unit.

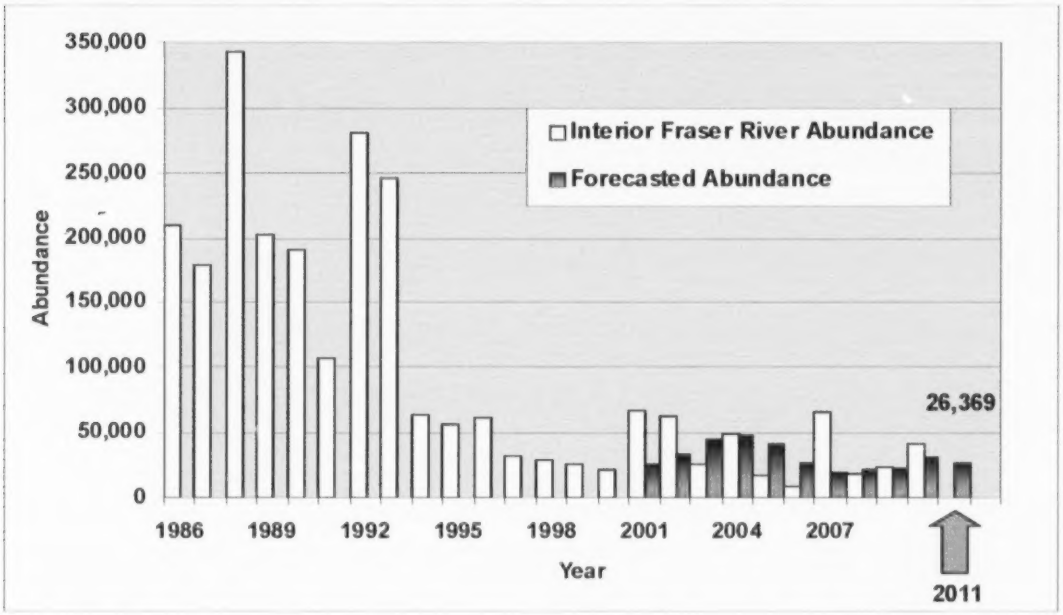

Figure 5. Interior Fraser River Watershed: forecasted and estimated abundances of coho salmon, 1986 – 2011.

Distribution and Return Timing

The P_{inside} statistic for 2011 (0.282) is similar to the 2010 value of 0.264 (Table 2) indicating a similar marine distribution as in 2010. which can be described as moderately outside. This indicates that coho should return to the Strait of Georgia later than average.

CONCLUSIONS

- The last full assessment of Southern B.C. coho was reviewed and endorsed through CSAS in 2004, with subsequent assessments presented in the form of a Science Advisory Report using the approved methodology. Since 2004, inclusion of new indicator streams, loss of indictor streams and model development has occurred. A full review of the assessment (forecast) methodology is recommended for future assessments.
- Coho marine survival and abundance continues to remain low (less than 3%) for most southern B.C. coho stocks compared to the early 1970's (15-20%). Of particular note, the 2011 Interior Fraser River Interior and Thompson Aggregates are forecasted to decline from 2010.
- In light of the abundance trend, coupled with the continuing low marine survival rates of southern B.C. coho stocks, the forecast of marine survival and abundance should be characterized as extremely low, with except possibly for the west coast of Vancouver Island.
- The 2010 marine survival for West Coast indicator stocks, Robertson Cr. (enhanced) and Carnation Creek (wild) were assessed at 3.3% and 1.0%, respectively. The 2011 marine survivals, based on favourable survival conditions and using newer, but not reviewed growth model, is forecast to increase over the observed values from the previous year.

- The estimated exploitation rates for southern B.C. coho salmon are becoming increasingly uncertain given the loss of escapement estimation, shifts in fishing pressures across all sectors and changes to the methods used to collect these data. The affect on the ability to assess stock status and provide forecasts is unknown. It was highlighted that monitoring all sources of mortality and CWT/AFC in all catch must be maintained and be responsive to shifting fishing pressures across all fishing sectors.

SOURCES OF INFORMATION

This Science Advisory Report is from the June 27-28, 2011 Regional Advisory Meeting on the Synoptic Assessment Framework for Assessing Conservation Unit Status for Pacific Salmon; and 2011 Marine Survival Forecast of Southern BC Coho. Additional publications from this process will be posted as they become available on the Fisheries and Oceans Canada Science Advisory Schedule at www.dfo-mpo.gc.ca/csas-sccs/index-eng.htm.

The data, models and treatments that were used in this report are fully documented in Simpson et al. (2004). Refer to that document for descriptions and background information.

Beamish, R.J., and Mahnken, C. 2001. A critical size and period hypothesis to explain natural regulation of salmon abundance and the linkage to climate and climate change. Prog. Oceangr. 49:423-437.

Bradford, M.J., Myers, R.A., and Irvine, J.R. 2000. Reference points for coho salmon (*Oncorhynchus kisutch*) harvest rates and escapement goals based on freshwater production. Can. J. Fish. Aquat. Sci. 57:677-686

Simpson, K., Chamberlain, M., Fagan, J., Tanasichuk, R. and Dobson, D. 2004. Forecast for southern and central British Columbia coho salmon in 2004. DFO Can. Sci. Advis. Sec. Res. Doc. 2004/135. 79p.

Trudel, M., Baillie, S., Parken, C., and O'Brien, D. 2008. Average growth for coho salmon in southern British Columbia. pp. 82-83 In Irvine, J. and B. Crawford (Eds). 2008. State of physical, biological, and selected fishery resources of Pacific Canadian marine ecosystems. DFO Can. Sci. Advis. Sec. Res. Doc. 2008/013: (http://www.dfo-mpo.gc.ca/csas/Csas/Publications/ResDocs-DocRech/2008/2008_013_e.pdf).

Trudel, M., Thiess, M.E., Bucher, C., Farley, Jr., E.V., MacFarlane, B., Casillas, E, Morris, J.F.T., Murphy, J.M., and Welch, D.W. 2007. Regional variation in the marine growth and energy accumulation of juvenile Chinook salmon and coho salmon along the west coast of North America. Am. Fish. Soc. Symp. Ser. 57: 205-232.

FOR MORE INFORMATION

Contact: Steve Baillie
South Coast Area, Fisheries and Oceans Canada
3225 Stephenson Point Road
Nanaimo, BC V9T 1K3
Tel: (250) 756-7227
Fax: (250) 756-7020
E-Mail: steve.baillie@dfo-mpo.gc.ca

This report is available from the:

Centre for Science Advice (CSA)
Pacific Region
Fisheries and Oceans Canada
Pacific Biological Station
3190 Hammond Bay Road
Nanaimo, BC V9T 6N7

Telephone: 250-756-7208
E-Mail: CSAP@dfo-mpo.gc.ca
Internet address: www.dfo-mpo.gc.ca/csas-sccs

ISSN 1919-5079 (Print)
ISSN 1919-5087 (Online)

La version française est disponible à l'adresse ci-dessus.

CORRECT CITATION FOR THIS PUBLICATION

DFO, 2012. 2011 Marine Survival Forecast of Southern British Columbia coho. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2012/037.